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THE EFFECTS OF DDT DUST AND SPRAY PREPARATIONS ON LARVAE OF THE EUROPEAN CORN BORER

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During the winter of 1944-45 laboratory experiments were conducted with a number of DDT dusts to determine the effects of different particle sizes, diluents, and concentrations of DDT on hibernating and actively feeding larvae of the European corn borer (Pyrausta nubilalis (Hbn.)). The results of these studies and their relation to field experiments conducted during the season of 1944 are presented herein.

Experiment With Hibernating Larvae

In this experiment various DDT dusts were compared with lead arsenate and rotenone dusts. Approximately 0.5 gram of each preparation to be tested was placed in each of ten 2-inch glass vials. A single hibernating larva, which had been collected during October and held in storage for 2 months at 38° F., was placed in each vial. The vials were shaken so as to cover the larvae thoroughly with dust. They were then stoppered with a plug of cellulose fiber and placed in an incubator where the temperature remained constant at 86°. No attempt was made to control the humidity. All tests were duplicated. The number of dead larvae was recorded every 24 hours.

Various characteristics of these dusts, as determined by the Division of Insecticide Investigations, are given in table 1. The bulk measurements were made with the Scott volumeter.

From the data in table 2 it is apparent that particle size is of some importance, since all micronized dusts were more efficient than the micropulverized dusts containing the same diluent. However, it is evident that other factors related to the carrier itself were operating, since the micronized talc mixture, although having a smaller mean diameter than the micropulverized clay or diatomaceous earth mixture, was less toxic than either of them. Of the three diluents used in the 50-percent DDT dusts, the clay and diatomaceous earth were much more efficient than the talc.

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Table 1.--Characteristics of micronized and micropulverized dusts containing 50 percent of DDT in various diluents

Diluent	Mean surface diameter (microns)		Bulk density (gm. per cc.)		Bulk voluminosity (cu.in. per lb.)		H- ion concentration (pH)	
	Micronized	Micropulverized	Micronized	Micropulverized	Micronized	Micropulverized	Micronized	Micropulverized
Absorbent clay	1.1	5.5	0.13	0.35	206	80	8.3	8.2
Diatomaceous earth	.8	2.1	.08	.15	331	191	5.7	5.6
Pyrophyllite 1/	3.7	-	.37	-	75	-	5.0	-
Fibrous talc	1.9	17.0	.12	.51	226	54	9.2	8.7

1/ Only 10.8 percent DDT in this dust.

Table 2.--Effectiveness of various DDT dusts on hibernating larvae exposed for different periods, Toledo, Ohio, 1945

Insecticide	Concentration of active ingredient, percent	Diluent	Average percent mortality after exposure for—				
			24 hours	48 hours	72 hours	96 hours	120 hours
DDT	50	Absorbent clay:					
		Micronized	100	-	-	-	-
		Micropulverized	10	50	70	70	100
		Diatomaceous earth:					
		Micronized	70	100	-	-	-
		Micropulverized	40	90	100	-	-
	10.8	Pyrophyllite	70	90	100	-	-
	50	Fibrous talc:					
		Micronized	0	0	0	35	80
		Micropulverized	0	0	0	0	0
	100	None	0	0	0	5	5
	5	Unknown 1/	0	0	0	0	0
Lead arsenate	96		0	0	0	5	5
Ground derris root	4.8 rotenone		100	-	-	-	-
Checks:							
Pyrophyllite			0	0	0	0	0
Untreated			0	0	0	0	0

1/ A commercial preparation.

The relatively high efficiency of the 10.8 percent DDT-pyrophyllite dust in comparison with the other mixtures is in agreement with the results obtained with this material in spray form in previous tests against feeding larvae,1/ and is in strong contrast with the extremely low mortality caused by the undiluted DDT powder. The lack of effectiveness of the 5 percent DDT in an unknown carrier is in general agreement with previous results obtained in the field,1/ where it was less effective than either the 10.8 percent DDT-pyrophyllite or the undiluted DDT, all applied as spray suspensions in approximately the same concentration of DDT.

The ground derris root killed all the larvae within 24 hours, but these larvae, in contrast to those killed by some of the DDT preparations, remained soft and normal in size. Lead arsenate caused no mortality until the fourth day, when only 5 percent were dead, and it did not cause any additional mortality on the fifth day.

Pyrophyllite alone caused no mortality and thus demonstrated that this diluent in itself was not responsible for the greater effectiveness of the 10.8 percent DDT-pyrophyllite dust than that caused by the undiluted DDT. What physical or chemical characteristics of the mixture were responsible for its much higher toxicity are not known. The comparative efficiency of the different mixtures tested apparently was associated with both particle size and identity of the diluents they contained.

Experiments With Feeding Larvae

The results of two feeding experiments, one in the laboratory and one in the field, to determine the toxicity of different DDT dusts used in spray suspensions to newly hatched corn borer larvae are given in tables 3 and 4. The comparative efficiency of the materials tested against feeding larvae was similar to that shown by the tests with hibernating larvae. These results suggest that for field use against the European corn borer a micronized DDT-absorbent clay mixture would be the most satisfactory of any of the preparations tested.

1/ Batchelder, C. H., and Questel, D. D. 1945. Experiments with DDT for the control of the European corn borer infesting sweet corn at Toledo, Ohio, in 1944. U.S. Bur. Ent. and Plant Quar. E-659, 11 pp.

Table 3.--Effect on newly hatched larvae of exposure for a 48-hour period to cauliflower leaves sprayed with various DDT preparations. Laboratory tests

Concentration of DDT, percent	Diluent	Average percent mortality of larvae exposed to indicated amount of DDT per 100 gallons of water					
		0.24 pound	0.12 pound	0.06 pound	0.03 pound	0.015 pound	0.0075 pound
50	Absorbent clay (micronized)	-	100.0	100.0	99.0	62.9	13.3
10.8	Pyrophyllite	-	100.0	98.3	16.2	1.4	0
100	None	93.2	83.0	36.8	6.0	0	0
5	Unknown	-	96.3	4.2	2.2	0	1.7
50	Fibrous talc (micro-pulverized)	100.0	92.6	11.2	5.3	0	0

Table 4.--Effectiveness of various DDT preparations against larvae infesting early-market sweet corn. Field tests, Toledo, Ohio, 1944

Concentration of DDT	Diluent	DDT per 100 gallons of water	Larvae		Reduction of borers	
			Per 100 plants	In ears from 100 plants	Per 100 plants	In ears from 100 plants
Percent		Pound	Number	Number	Percent	Percent
10.8	Pyrophyllite	0.432	38	4	97.9	99.2
100	None	.50	70	20	96.2	96.0
5	Unknown	.40	114	36	93.8	92.7
-	Check (untreated)	-	1834	496	-	-

Action of Toxic Agent on Hibernating Larvae

A striking effect of the DDT dusts that killed the larvae in a comparatively short time was a shrinking, desiccation, and hardening of the larvae. When death did not occur rapidly, however, as in the treatments utilizing undiluted DDT, shrinking and hardening did not take place even though convulsive movements and partial paralysis were evident. The rapid mortality caused by ground derris root showed no evidence of shrinking, desiccation, and hardening. The contrast in appearance of larvae killed quickly by DDT and by derris is shown in figure 1. The characteristic shrinking and hardening of the larvae subjected to the rapidly killing DDT mixtures may provide a clue to the manner in which the active agent in these mixtures causes death.

Discussion

It seems of particular interest to note from the foregoing observations that (1) the percentage of DDT in a dust appeared to have less effect on toxicity than the physical and chemical character of the mixture of DDT and diluent, (2) rapidly killing DDT dust mixtures caused a definite shrinking and hardening of the hibernating larvae, whereas ground derris powder that killed equally as rapidly did not, (3) the toxicity of the various materials tested as contact poisons against hibernating larvae closely paralleled that obtained in feeding tests against newly hatched larvae in the laboratory and against young larvae infesting sweet corn in the field, in those cases where both types of tests were conducted, and (4) a group of mixtures containing an active agent which kills by contact can perhaps be evaluated readily by laboratory tests to determine their effects on hibernating larvae.

Summary

Experiments with several DDT dust and spray preparations conducted against both hibernating and actively feeding larvae of the European corn borer (Pyrausta nubilalis (Hbn.)) indicate that the percentage of DDT (1-trichloro-2,2-bis(p-chlorophenyl)ethane) may have less bearing on the effectiveness of the dusts and sprays than some other factors perhaps related to the physical or chemical character of the diluent. Hibernating larvae thoroughly coated with a powder containing 10.8 percent of DDT in pyrophyllite, or with 50 percent of DDT micronized with an absorbent clay or diatomaceous earth, were all killed within 3 days, whereas none, or not more than 5 percent, of those coated with powders containing 50 percent of DDT micropulverized with a fibrous talc, or with coarsely ground undiluted technical DDT, were killed within 5 days. The toxicity of the various mixtures to hibernating larvae closely paralleled that obtained in feeding tests against newly hatched larvae in the laboratory and against larvae infesting sweet corn in the field. Rapidly killing DDT dusts caused definite and characteristic shrinking, desiccation, and hardening of the larvae. Larvae killed as rapidly by ground derris powder (4.8 percent rotenone) remained soft and normal in size.

Figure 1.--Hibernating European corn borer larvae killed within 24 hours by exposure at 86° F. to two insecticidal dusts: Left, larvae killed with a dust containing 50 percent of DDT. Right, larvae killed with a ground derris root powder (4.8 percent rotenone).

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